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# PUMPS

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# Agenda

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1. Overview of pumps
2. Pumps types
3. Pump Curves, Operating Point & System Curve
4. Efficiency

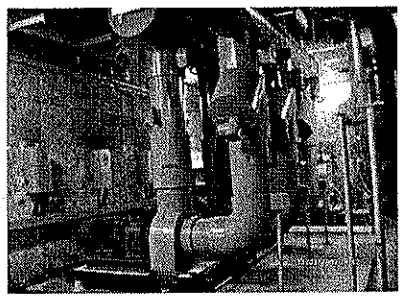
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# Overview of pumps

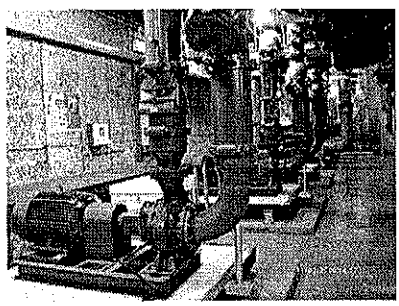


# Pumps for chilled water plant

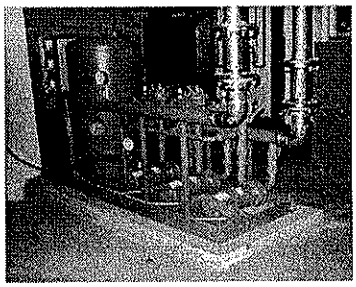
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Chilled Water Pump



Condenser Pump



Cooling tower make up water pump



Water treatment dosing pump

# Pumps are everywhere in a building

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- Chilled water pumps
- Condenser water pumps
- Cooling tower make up water pumps
- Cooling tower water treatment pumps
- Condensate water pumps (collection of condensate)
- Domestic cold water pumps
- Domestic hot water pumps
- Booster pumps
- Basement sump pumps



# World pumping energy

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- American Hydraulic Institute's research indicates that electric motors in pump systems consume 13% of the world's total electricity output, and that many pump systems run at 60% efficiency or less.

http://www.engineeringnews.co.za/article/heavy-industry-urged-to-improve-pump-energy-efficiency-2008-10-03

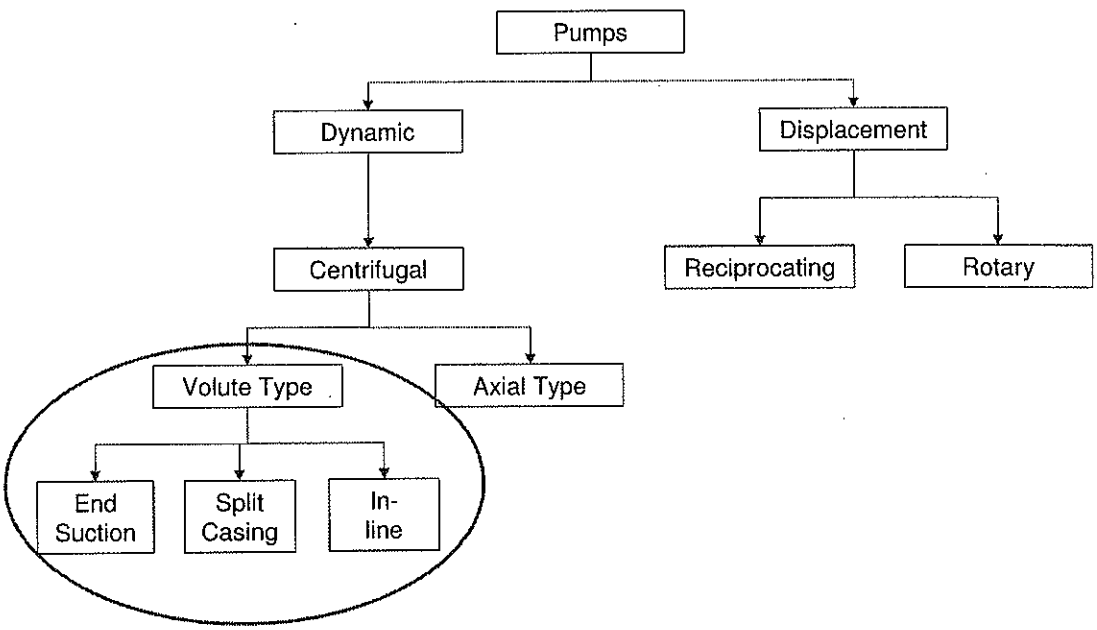
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# PUMP TYPES



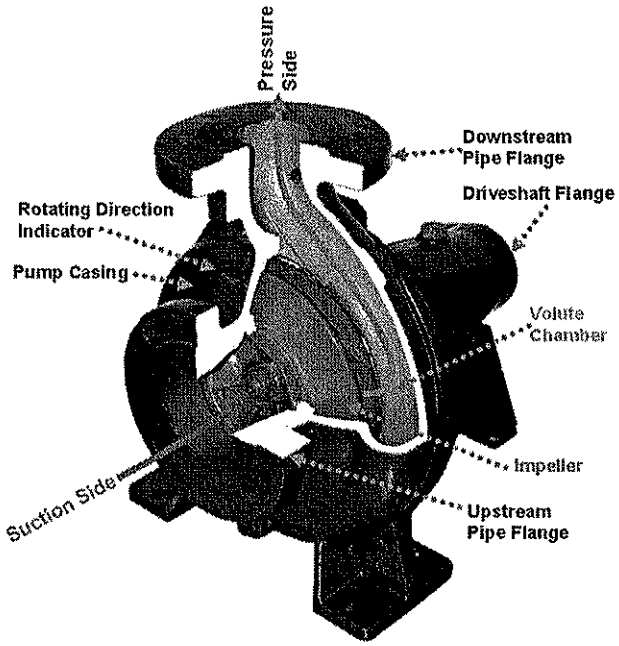
# Pumps in HVAC

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# End suction centrifugal pump

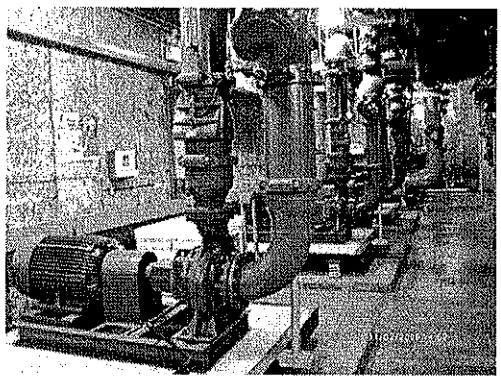
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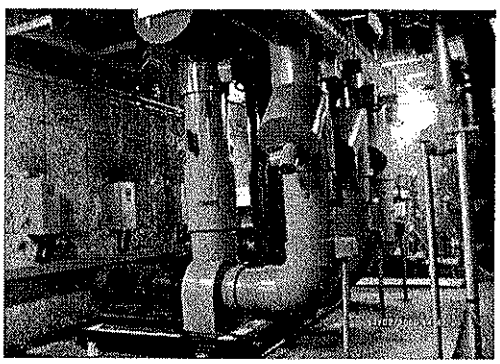


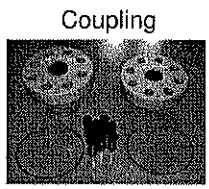


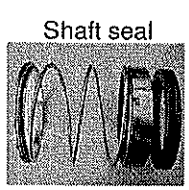

# End suction centrifugal pump

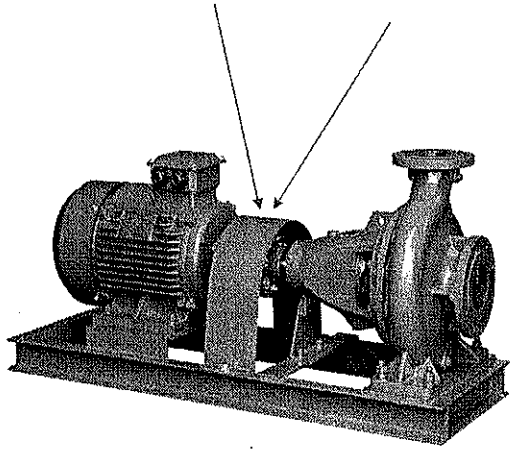
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# End suction centrifugal pump

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## Performance Range

- Capacity: 2 to 1400$m^3$/h
- Head: 2 to 115m
- Efficiency : up to 90%
- Impeller Dia: 125-381mm
- Motor Power: 0.18-200kW
- Motor speed: 2, 4, 6pole
- Frequency: 50Hz, 60Hz
- Max. working pressure: 1.2MPa



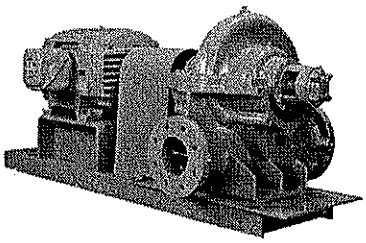
# Component Material

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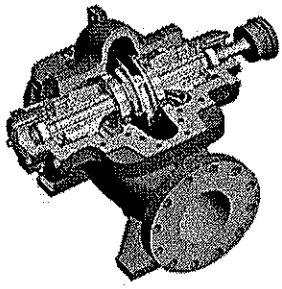
| Component | Material Combination | | | | |
|---|---|---|---|---|---|
| | Standard | Option | Option | Option | Option |
| Volute | Cast Iron | Cast Iron | Ductile Iron | Ductile Iron | Bronze |
| Impeller | 304SS | Bronze | 304SS | Bronze | Bronze |
| Seal Housing | Cast Iron | Cast Iron | Ductile Iron | Ductile Iron | Bronze |
| Backplate | Cast Iron | Cast Iron | Ductile Iron | Ductile Iron | Bronze |
| Shaft | 420SS | Carbon Steel | 420SS | Carbon Steel | 316SS |
| Case Wear Ring | Bronze | Bronze | Bronze | Bronze | Bronze |
| Bearing Frame | Cast Iron | Cast Iron | Cast Iron | Cast Iron | Cast Iron |
| Slinger | Rubber | Rubber | Rubber | Rubber | Rubber |

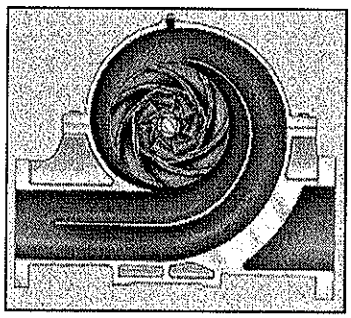
# Split casing centrifugal pump

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Horizontal coupled motor

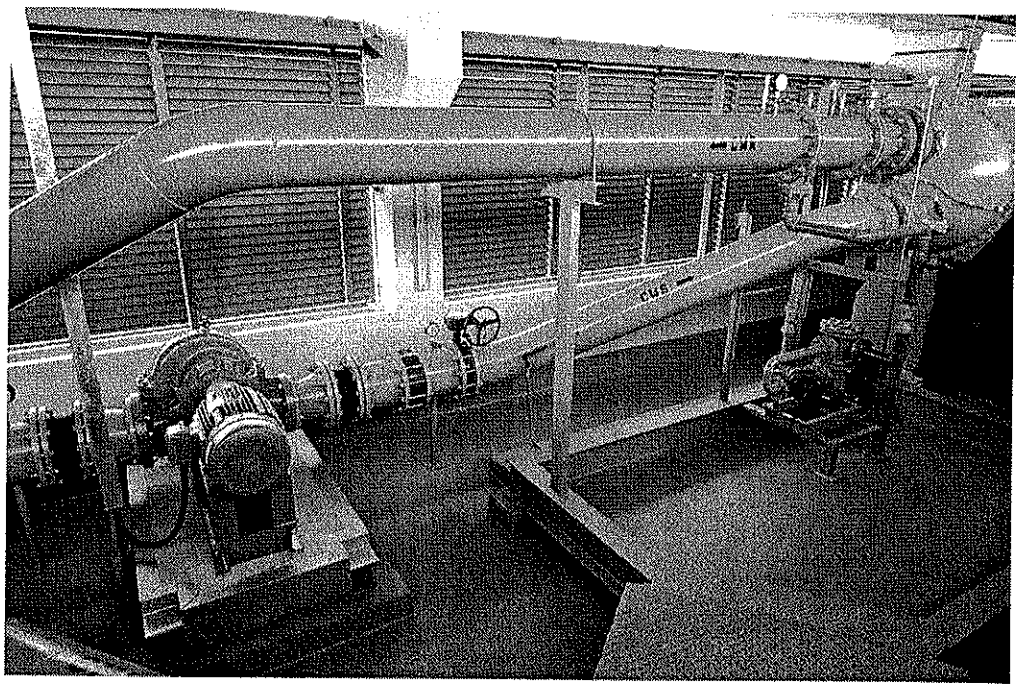






# Centrifugal pumps – Split casing type

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# Split casing centrifugal pump

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## Performance Range

- Capacity: 8 to 14,000 $m^3/h$
- Head: 5 to 210m
- Max. efficiency : up to 92%
- Motor power: 0.37 to 3000KW
- Motor speed: 2, 4, 6, 8, 10 pole
- Frequency: 50Hz, 60Hz



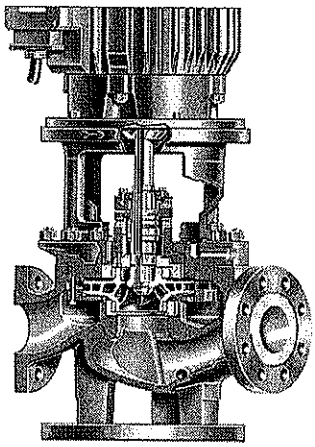
# Component Material

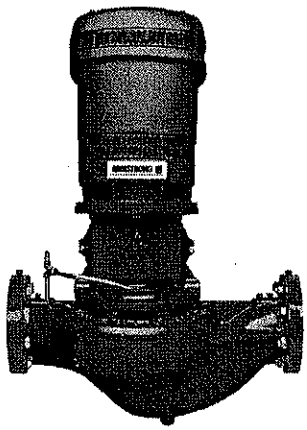
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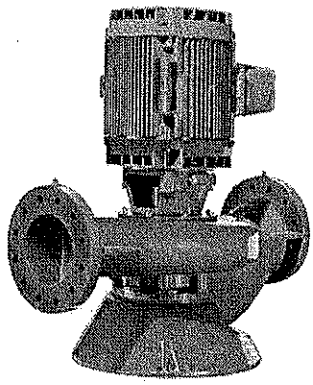
| Item | Cast Iron S.S. Fitted | | Ductile Iron S.S. Fitted | | All Stainless Steel | | All Bronze | |
|---|---|---|---|---|---|---|---|---|
| | Material | Spec.NO. | Material | Spec.NO. | Material | Spec.NO. | Material | Spec.NO. |
| Casing | Cast Iron | A48 | Ductile Iron | A536 | St.Steel | AISI-300 | Bronze | B145 |
| Case Wear Ring | Cast Iron | A48 | Ductile Iron | A536 | St.Steel | AISI-300 | Bronze | SAE660 |
| Bearing Housing | Cast Iron | A48 | Ductile Iron | A536 | St.Steel | AISI-300 | Bronze | B145 |
| Casing Bolts | Steel | Grade 8 Com.std. | Steel | Grade 8 Com.std. | St.Steel | AISI-300 | St.Steel | AISI-300 |
| Brg.Housing "O"Ring | Synthetic | Buna-N | Synthetic | Buna-N | Synthetic | Buna-N | Synthetic | Buna-N |
| Case Gasket | Vegetable Fiber | HYD-401 | Vegetable Fiber | HYD-401 | Vegetable Fiber | HYD-401 | Vegetable Fiber | HYD-401 |
| Brg.Housing Bolts | Steel | Grade 8 Com.std. | Steel | grade 8 Com.std. | Steel | grade 8 Com.std. | St.Steel | AISI-300 |
| Bearing Cap | Cast Iron | A48 | Cast Iron | A48 | Cast Iron | A48 | Cast Iron | A48 |
| Bearing Cap Bolts | Steel | Grade 8 Com.std. | Steel | grade 8 Com.std. | Steel | grade 8 Com.std. | St.Steel | AISI-300 |
| Bearing Cap Gasket | Vegetable Fiber | HYD-401 | Vegetable Fiber | HYD-401 | Vegetable Fiber | HYD-401 | Vegetable Fiber | HYD-401 |
| Impeller | St.Steel | AISI-300 | St.Steel | AISI-300 | St.Steel | AISI-300 | Bronze | B145 |
| Impeller Wear Rings | Bronze | SAE660 | Bronze | SAE660 | St.Steel | AISI-300 | Bronze | SAE660 |
| Impeller Key | Steel | C1018 | Steel | C1018 | St.Steel | AISI-300 | St.Steel | AISI-300 |
| Shaft | St.Steel | AISI-420 | St.Steel | AISI-420 | St.Steel | AISI-300 | St.Steel | AISI-300 |
| Shaft Sleeve | St.Steel | AISI-300 | St.Steel | AISI-300 | St.Steel | AISI-300 | Bronze | SAE660 |
| Packing Gland | St.Steel | AISI-300 | St.Steel | AISI-300 | St.Steel | AISI-300 | Bronze | B145 |
| Gland Studs | St.Steel | AISI-300 | St.Steel | AISI-300 | St.Steel | AISI-300 | St.Steel | AISI-300 |
| Recirculation Lines | TEFE Tubing | Com.std. | TEFE Tubing | Com.std. | TEFE Tubing | Com.std. | TEFE Tubing | Com.std. |
| Recirculation Fittings | Brass NPT | Com.std. | Brass NPT | Com.std. | St.Steel | AISI-300 | Brass NPT | Com.std. |
| Lantern(Optional) | St.Steel | AISI-300 | St.Steel | AISI-300 | St.Steel | AISI-300 | St.Steel | AISI-300 |
| Mechanical Seal | Seal face:Silicon carbide Vs Carbon, Metal:316SS, O-ring:Viton | | | | | | | |

# Inline Centrifugal Pump

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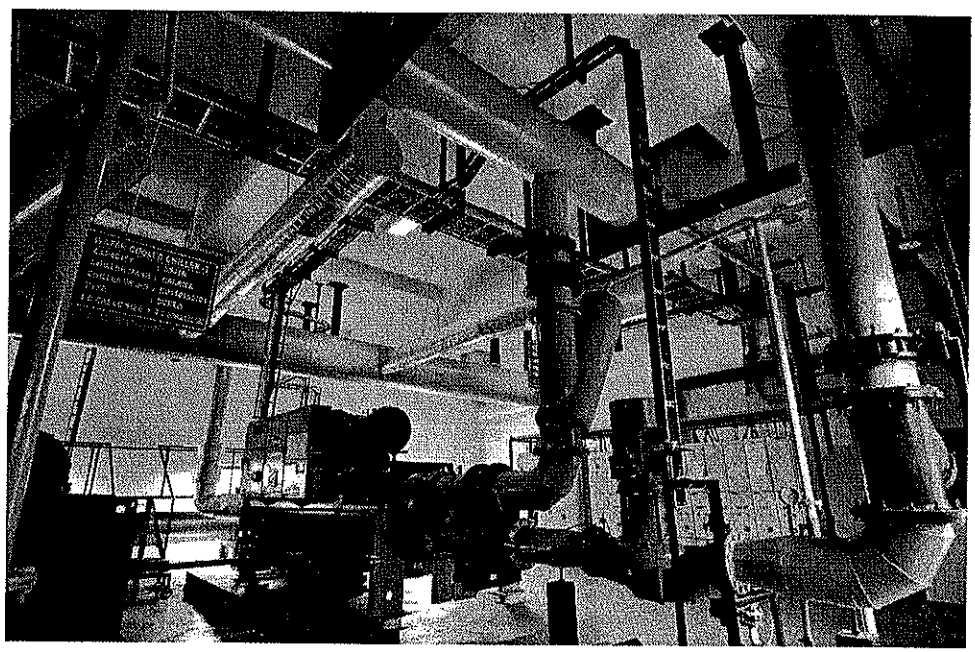






# Inline centrifugal Pump

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# Inline centrifugal pump

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Performance Range

- Capacity: 8 to 6500 $m^3/h$
- Head: 5 to 150m
- Max. efficiency : 90%
- Motor power: 0.75 kW to 900 kW
- Motor speed: 2, 4, 6, 8, 10 pole
- Frequency: 50Hz, 60Hz

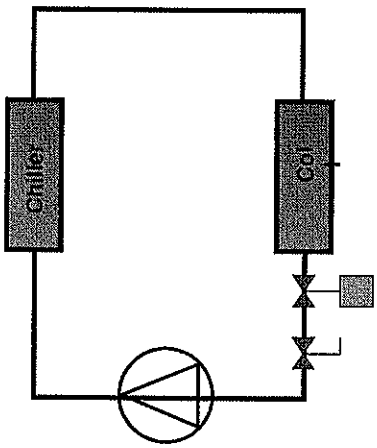


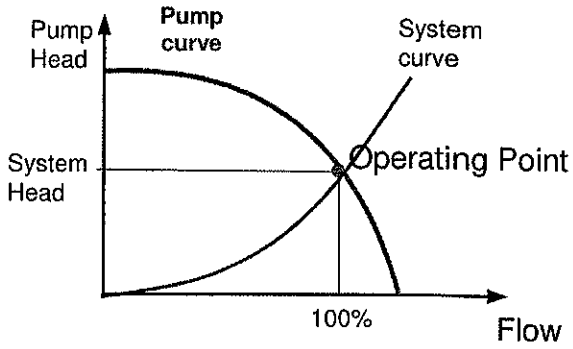
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# PUMP CURVE, OPERATING POINT & SYSTEM CURVE

# Pump Curve

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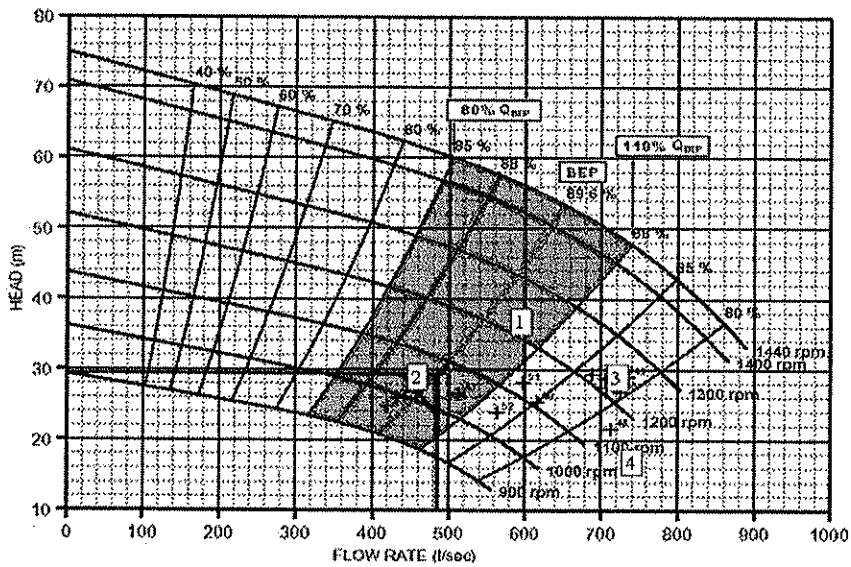





# System Curves for a Pump Type

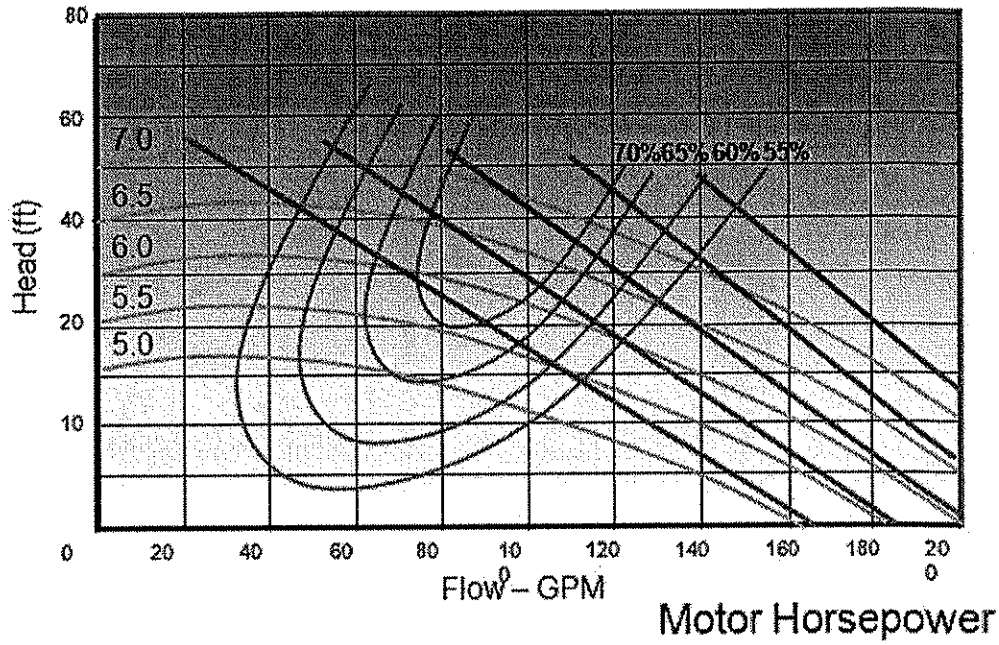
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1 Pump Best Efficiency Point (BEP)
2 Ideal pump duty
3 Pump operating to the right of BEP
4 Pump cavitating (very far right of BEP)

# System Curves for a Pump Type

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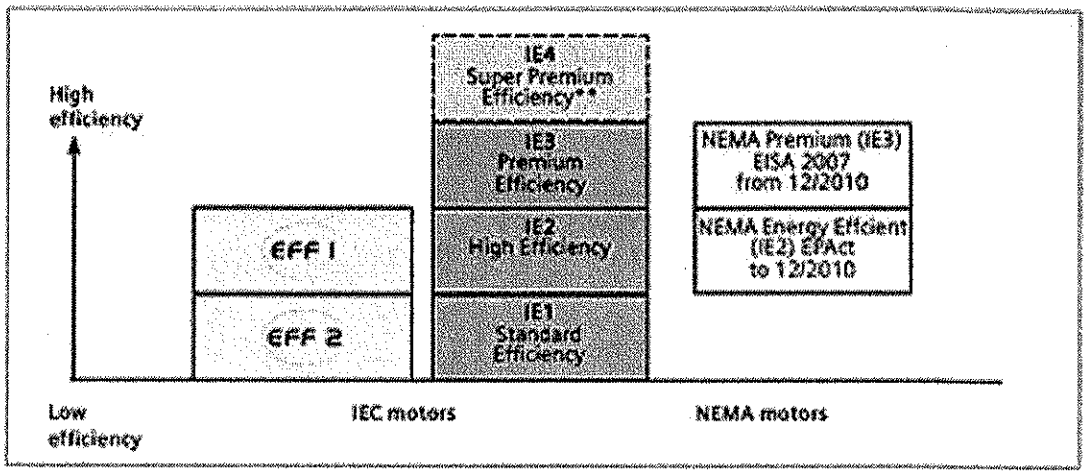



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# EFFICIENCY

# Motor Efficiency

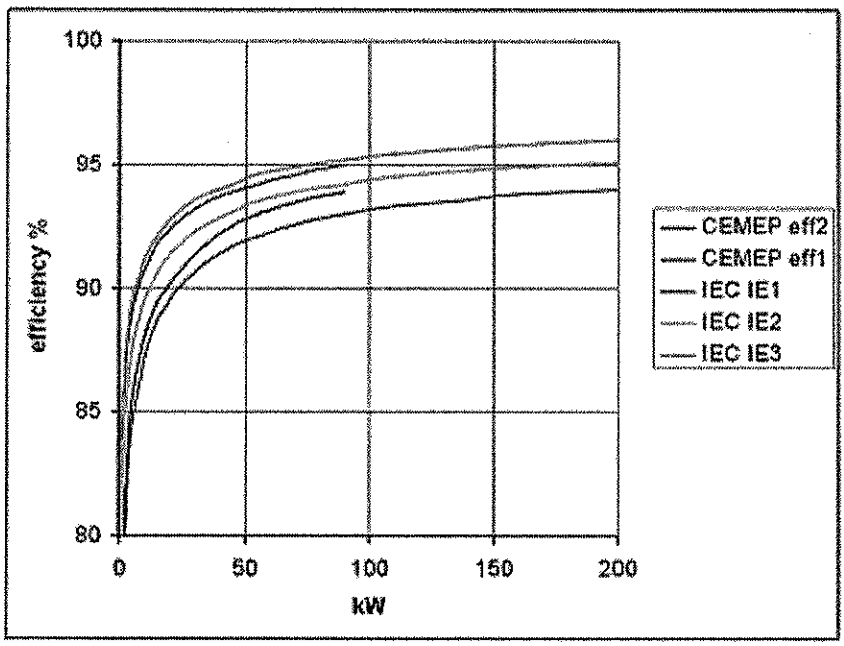
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# Motor Efficiency

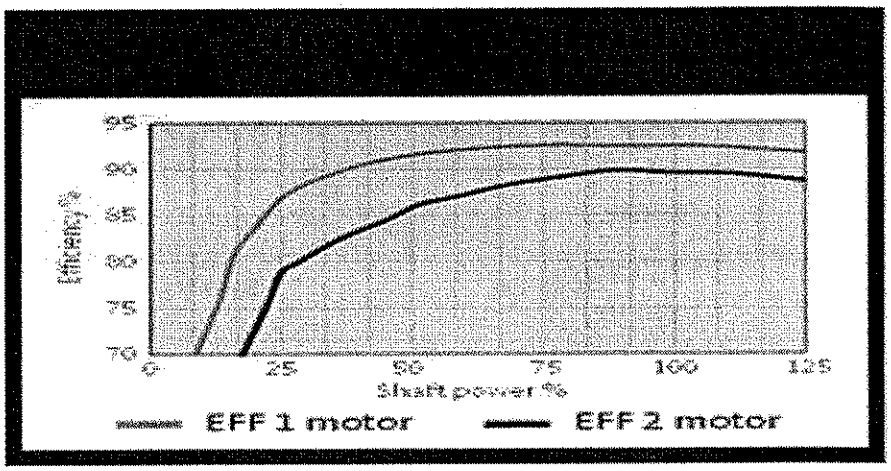
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# Motor efficiency

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- The motor efficiency is dependent on the type of motor (EFF1 or EFF2) and the load of the motor (shaft power). A low load (below 25%) means a significant drop in efficiency.

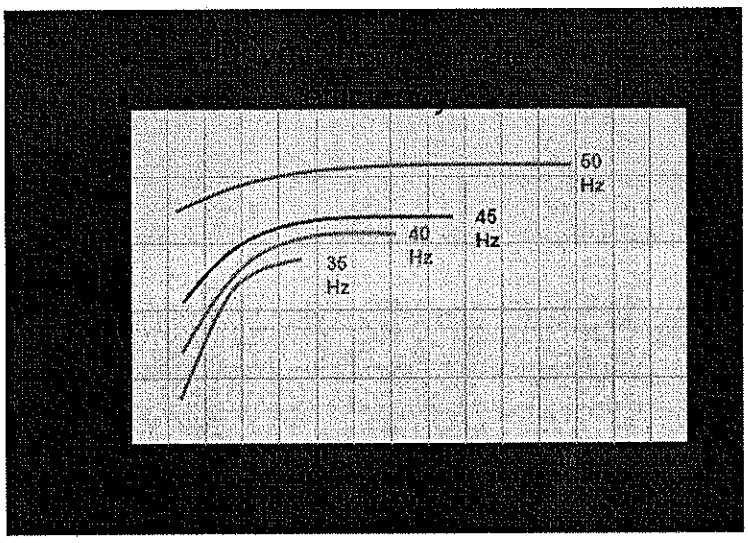





# Drive Efficiency

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- The drive efficiency is dependent on the load of motor and the frequency output, but the efficiency down to 30% load is more or less constant.



# Pump power

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$$\text{Pump power} = \frac{\text{Flow rate x Head}}{1000 \times \eta\text{pump} \times \eta\text{motor}}$$

Where:
Pump power: KW
Flow rate: L/s
Head: kpa
ηpump: Pump efficiency (%)
ηmotor: Motor efficiency (%)



# Energy Efficiency Opportunities

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| Efficiency Measures | Range of Savings (% of system energy) |
|---|---|
| Reduce Overall System Requirements | 5-20% |
| Match Pump Size to Load | 10-30% |
| Reduce or Control Pump Speed | 5-50% |
| Component Purchase | 1-3% |
| Operation & Maintenance | 1-5% |

Source: US Industrial Motor Systems Market Opportunities Assessment US Dept. of Energy, 1998

# Pump vs. System Standards

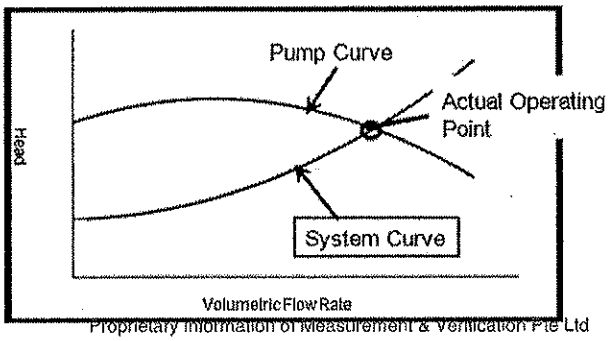
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**Pump Standards**

- Pump design is subject to numerous standards
  - HI, API, ANSI, ISO.
- Pump hydraulic data is subject to numerous standards
  - Developed head, Efficiency, NPSHr

**System Standards**

- With few exceptions, there are no standards to guide system design
- Engineering contractors and owner/operators are allowed to choose (or ignore) how to calculate system hydraulics
  - Specified pump operating point not subject to standards




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# Tips for Energy Saving

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- Improve piping configuration
  - Use larger pipe sizes
  - Eliminate unnecessary turns, valves, accessories
  - Optimize pump inlet and outlet piping
- Minimize throttling
- Assess pumping system suitability for current application. Many installed systems are oversized, providing an opportunity to:
  - Install a smaller impeller or trim the existing one
  - Remove stages
  - Downsize pump
  - Install a smaller and/or a more efficient pump motor
  - Replace worn impellers

# Tips for Energy Saving

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- Reduce pump speed or install appropriate speed control devices
  - Install a slower speed motor
  - Change sheave diameters
  - Consider variable frequency drives
- Consider alternative pump configurations
  - Pony pumps
  - Multiple pumps in parallel
- Eliminate unnecessary uses
  - Schedule pumps to turn off whenever possible
  - Avoid recirculation through bypass lines
- Improve O&M practices
  - Establish basic system maintenance checklists and schedules
  - Establish a predictive maintenance program

# THANK YOU

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